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1            Scope:

This procedure outlines steps to complete final assembly of the Cryostatted magnet. Included are Conflat flange removal, roll flange installation, and heat shield crossover line installation. Also covered is final survey and pressure leak check.

2            Applicable Documents:

14060005	D1 Magnet Assembly, Tested & Shipped
<a href="#">RHIC-MAG-Q-1004</a>	<a href="#">Discrepancy Reporting Procedure</a>
<a href="#">LHC-MAG-R-1038</a>	<a href="#">D1/D2/D3/D4 Twist Check and Fiducial Survey</a>
<a href="#">LHC-MAG-R-1045</a>	<a href="#">LHC Lower Heat Shield Pressure and Leak Check Procedure</a>

3            Requirements:

3.1          Material/Equipment:

25-1782.02-5	Lifting Beam
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3.2          Safety Precautions:

3.2.1       Operators shall be trained by their cognizant technical supervisor and qualified in the operation of the welding equipment.

3.2.2       No welding shall take place unless all welding screens are in place around the welding station, and all personnel not directly involved with the welding process are outside the screens. Any personnel inside the screens shall wear protective gear to prevent eye injury, and shall be clothed to prevent burns caused by intense ultra-violet light.

3.2.3       Caution - D1 assemblies will be rigged using the 25-1782.02 lifting beam and slings so no chafing protection is required.

3.2.4       All lifting and handling operations requiring overhead crane operations shall be performed by holders of valid Safety Awareness Certificates. They shall also be instructed in the use of the appropriate lifting device by the Technical Supervisor.

3.2.5       Technicians performing Pressure Testing shall be instructed in the procedures prescribed by the BNL ES&H Standard 1.4.0 /1.4.1 /5.1.0 for operating pressurized gas systems and in the use of nonflammable cryogens by the Technical Supervisor.

- 3.2.6 Examine all pressure test equipment before pressure is applied to ensure it is tightly connected.
- 3.2.7 Suitable precautions shall be taken during pressure testing to eliminate hazards to personnel in the proximity of the test in the event of a rupture.
- 3.2.8 Safety glasses must be worn during potential eye damaging operations.
- 3.2.9 All relief devices and gauges used for pressure tests shall meet the requirements of ES&H standard 1.4.1.
- 3.3 Procedure:
  - 3.3.1 Final Survey
    - 3.3.1.1 Install the six Taylor-Hobson fiducial sockets. Each fiducial has three set screws which are adjusted to protrude 2mm from the bottom surface. Plug threaded holes as well as perimeter of ring with Apiezon sealant.
    - 3.3.1.2 Pour in enough epoxy to come up the sides of the fiducial by only 1-3mm (approximately 60 ml.). Center the fiducial in the ring and tighten socket cap screws over Belleville washers. Allow epoxy to cure for 24 hours before proceeding to next step.
    - 3.3.1.3 Complete final optical survey per LHC-MAG-R-1038 Section 4.3 and attach data to traveler.

**NOTE**

**This will tie in the T-H fiducials with the BNL cryostat fiducials and the end volume fiducials.**

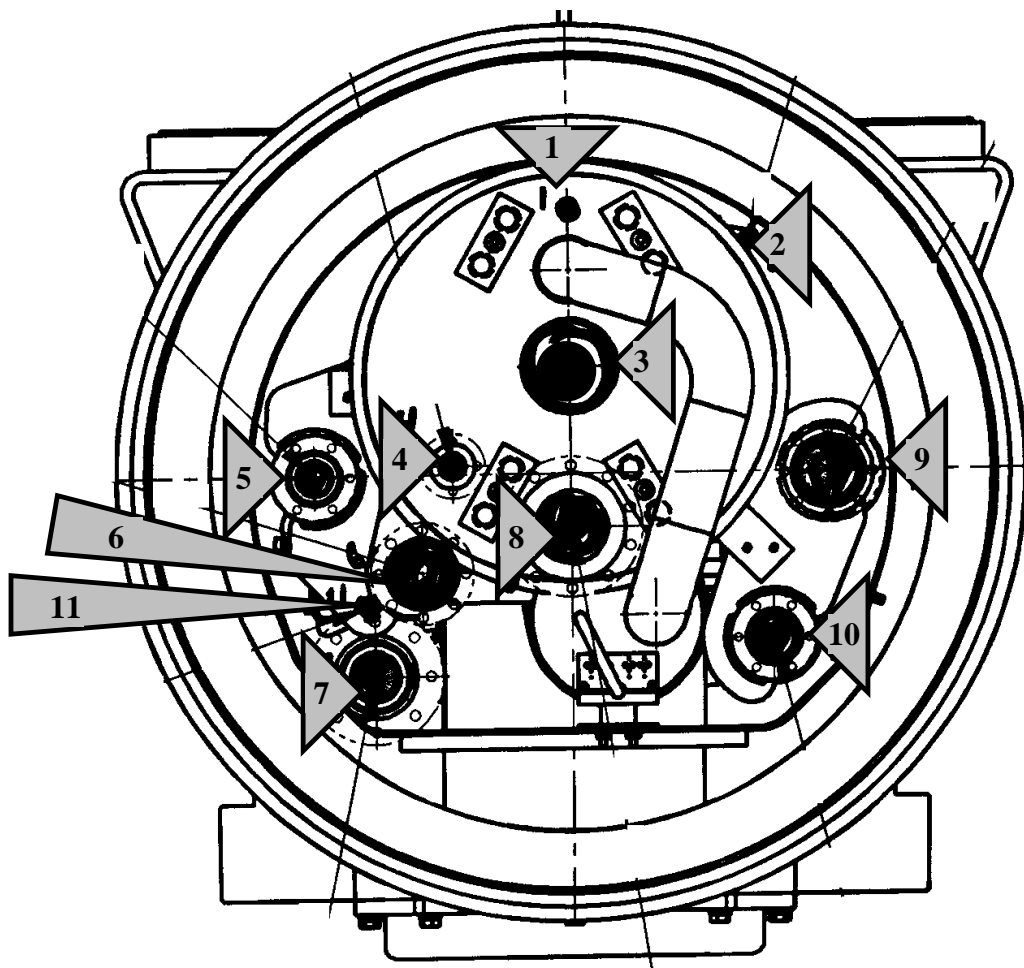
- 3.3.1.4 Perform optical survey of the eleven lines at the LE and two lines at the NLE of the cryostat. Determine X, Y & Z coordinates for the point @ the center of the tube at the tubes' extreme end. See figure 1 for naming convention for these data points. Attach data sheet to traveler.

**NOTE**

**Longitudinal measurements taken here are preliminary. Final measurements will be performed after trimming of lines.**

Figure 1 - Identification of Lines for Survey  
*View Looking at LE of Cryostat. Top of Magnet UP*

ID	Identifier	Description
1	PCY	1.9K Helium Line (cy)
2	PCYT	1.9K Helium Transfer Line (cy <sub>t</sub> )
3	BTLE	Beam Tube
4	PIN	Instrumentation Stub (i)
5	PC	4.5K Helium Supply (c)
6	PXB	Vent Line (xb)
7	PE1	Heat Shield Supply (e <sub>1</sub> )
8	PMC	Main Bus (m/c)
9	PXBT	Vent Transfer Line (xb <sub>t</sub> )
10	PE2	Heat Shield Return (e <sub>2</sub> )
11	PBS	Beam Screen (c ' )
-	PBS	<b>NLE</b> Beam Screen (c ' ) <i>Not Shown</i>
-	BTNLE	<b>NLE</b> Beam Tube <i>Not Shown</i>



3.3.2 Final Assembly & Cryogenic Line Trimming

- 3.3.2.1 Prepare for welding the heat shield crossover flex line subassembly at the NLE. Perform a “dry fit” before cutting any material. Cut the heat shield supply line( $e_1$ ) thereby removing the Conflat flange at the NLE. Then tack the flex hose assembly into place. Purge the lines with argon gas and complete welding.

**NOTE**

**Do not exceed maximum protrusion dimension of elbow from face of cryostat flange.**

**CAUTION**

**Be careful not to damage insulation blankets by overheating.**

- 3.3.2.2 Perform a pressure check of the heat shield supply and return lines ( $e_1$  &  $e_2$ ) @ 400 PSIG. Perform test per LHC-MAG-R-1045 Sections 3.3.1-3.3.2.6 except do not perform 3.3.1.2 "*Mount assembly onto bench*".

**NOTE**

**Pressure test shall be witnessed by the ES&H Coordinator or Safety Engineering**

- 3.3.2.3 Perform a vacuum leak check of the heat shield supply and return lines ( $e_1$  &  $e_2$ ) per LHC-MAG-R-1045 Section 3.3.3. The maximum acceptable leak rate is  $2 \times 10^{-10}$  Std. cc He /Sec.
- 3.3.2.4 Cut off the conflat test flange from the heat shield supply line ( $e_1$ ) at the LE and install the specified reducer, adapter, and machined flange in its place. The tube must be trimmed such that the front face of the flange will be at the specified dimension from the face of the lead end volume after weld shrinkage.
- 3.3.2.5 Install the specified reducer, adapter, and machined flange onto the heat shield return line ( $e_2$ ) at the LE. If necessary, trim the pipe so that the front face of the flange will be at the specified dimension from the face of the lead end volume after weld shrinkage.
- 3.3.2.6 Using a small WACHS cutter, trim beam tube to the specified length from the face of the end volume at each end. Use cutting lubricant very sparingly and only

prior to breaking through. Just before breaking through, clean away lubricant with ethanol, then make final cuts dry.

**NOTE**

**No cutting oil shall enter the beam tube.**

- 3.3.2.7 Deburr tube ends of beam tube as a last step. Finally, clean and degrease beam tube ends thoroughly with ethanol.
- 3.3.2.8 Cut off the Conflat test flange from the m/c (main bus) stub at the LE and install the specified roll flange in its place. The pipe must be trimmed such that the front face of the flange will be at the specified dimension from the face of the lead end volume after weld shrinkage. Be extremely careful not to damage the bus cables in the pipe. Install adequate shielding sleeve and weld slowly, air cooling periodically to minimize heat buildup.
- 3.3.2.9 Cut off the Conflat test flange from the "I" (instrumentation) stub at the LE and install the 1" machined flange in its place. The tube must be trimmed such that the front face of the machined flange will be at the specified dimension from the face of the lead end volume after weld shrinkage. Be extremely careful not to damage the instrumentation wires in the pipe. Install adequate shielding sleeve and weld slowly, air cooling periodically to minimize heat buildup.
- 3.3.2.10 Trim the ½ inch diameter 1.9k transfer line (Cyt) at the lead end to the specified length. This line is located on the outside of the shell and runs the full length of the cold mass. Deburr and clean after cutting.
- 3.3.2.11 Trim the ½ inch diameter 1.9k supply stub (Cy) at the LE back to the specified length from the face of the lead end volume. This stub protrudes out the face of the lead end volume at the twelve 0'clock position. Deburr and clean after cutting.
- 3.3.3 Final Trimming of Lines

**NOTE**

**Phase Separator Vent Line (Xb): Emerges from the left side of the LE phase separator and comes out at the lower left side of the LE.**

**Phase Separator Transfer Line (Xbt): Runs the full length of the cold mass, emerging from the NLE phase separator, and exiting out the lower right side at the LE.**

**4.5k Helium Supply Line (c):** Runs along the left side for the full length of the magnet. It makes a U-turn and enters the face of the NLE end volume with a 1 inch tube.

**Beam Screen (c'):** Is 5/8 diameter and is under the cold mass and is located approximately left-center.

**Left / Right convention used:** Standing at LE looking towards NLE - Top of magnet UP.

- 3.3.3.1 Cut the phase separator vent transfer line (Xbt) at the lead end to the specified length. Discard the Conflat flange. Deburr and clean the tube after cutting.
- 3.3.3.2 Cut the phase separator vent tube stub (Xb) at the lead end to the specified length. Discard the Conflat flange. Deburr and clean after cutting.
- 3.3.3.3 If necessary, cut the 5/8 inch diameter beam screen supply line (c') back to the specified length from the face of the lead end volume. Deburr and clean after cutting.
- 3.3.3.4 If necessary, cut the 5/8 inch diameter beam screen supply line (c') back to the specified length from the face of the NON-LEAD end volume. Deburr and clean after cutting.
- 3.3.3.5 Cut the heat shield return line  $\Theta_2$  at the lead end to the specified length. Deburr and clean the tube after cutting.
- 3.3.3.6 Cut the 4.5k helium supply line (c) at the lead end to the specified length. Discard the Conflat flange. Deburr and clean after cutting.
- 3.3.3.7 Affix decal with BNL logo as shown on the assembly drawing.
- 3.3.4 End Volume Blanket Installation
  - 3.3.4.1 Install end volume flange blankets at LE and NLE. At LE, feed instrumentation harness through appropriate cut in blanket. Fiducial block sides must be insulated, but faces visible. Trim as necessary.
  - 3.3.4.2 Install sleeve insulation over end volume sleeve at both ends. Tuck underneath heat shield 1.0-1.5 inches while squeezing it at 3:00 & 9:00 o'clock positions to gain clearance at 12:00 o'clock position. The blanket goes under the phase separator lower vent line as indicated and the lower flap must completely cover the end of the phase separator.

3.3.4.3 Secure blankets as indicated using Mylar tape and Kevlar lacing cord. Epoxy the knots as shown.

3.3.4.4 At the NLE, spiral wrap insulation onto the 1 inch diameter helium supply line (c), the ½ inch diameter transfer line (Cyt), phase separator riser, and the heat shield crossover ( $e_1 \rightarrow e_2$ ). Use two layers, butt wrapped. Stagger the seams between the inner and outer layer.

3.3.4.5 At the LE, spiral wrap insulation onto the phase separator riser. Use two layers, butt wrapped. Stagger the seams between the inner and outer layer.

3.3.5 Final Measurement of Lead End Lines

3.3.5.1 Measure and record the distance from the LE End Volume to the end of each tube listed in figure 1. Record in traveler.

3.3.5.2 Cognizant engineer to review data and compare to LHC interface specification. Sign off "Ok to Proceed".

4 Quality Assurance Provisions:

4.1 The Quality Assurance provisions of this procedure require that all assembly and test operations be performed in accordance with the procedural instructions contained herein.

4.2 Measuring and test equipment used for this procedure shall contain a valid calibration label in accordance with RHIC-MAG-Q-1000.

4.3 All discrepancies shall be identified and reported in accordance with RHIC-MAG-Q-1004.

5 Preparation for Delivery:

N/A